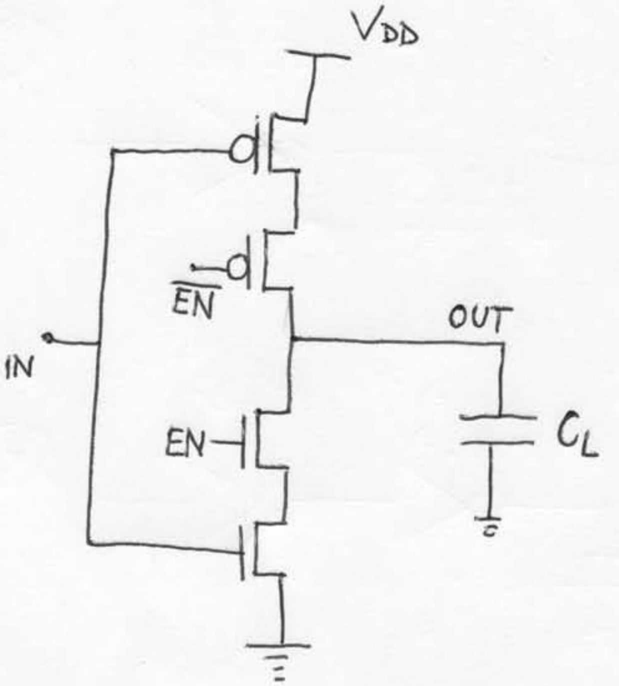
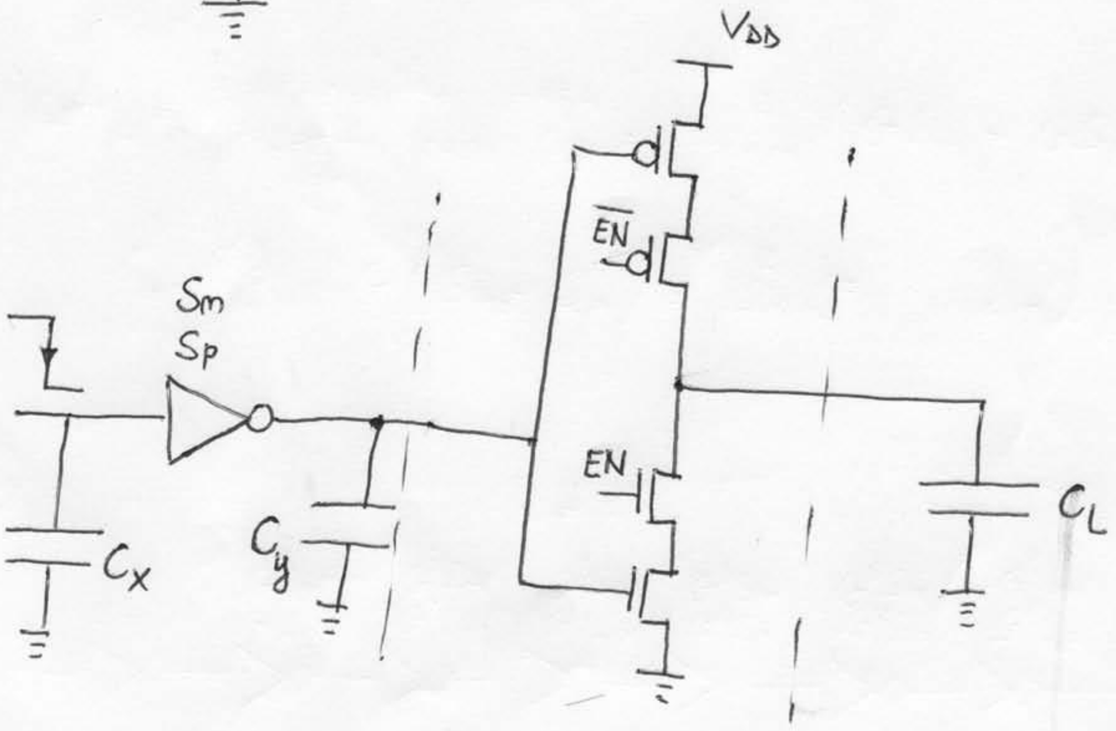
BUFFER TRI-STATE



IN	EN	OUT
0	0	Hi-Z
0	1	1
1	0	Hi-Z
1	1	0

BUFFER INVERTENTE



$GS_m \ , \ GS_p$

$$\tau_{DELAY} = t_{r(1)} + t_{f(2)}$$

$$C_y = C_{ox} L_{min}^2 (GS_m + GS_p) = G \ C_{ox} L_{min}^2 (S_m + S_p) =$$
$$= G \ C_x$$

$$t_{r(1)} = \frac{2\,C_y}{\beta_p' \cdot S_p} \cdot F_p = G\,\frac{2\,C_X}{\beta_p}\,F_p = G\,\tau_{typ}$$

$$t_{f(2)} = \frac{2\,C_L}{\beta_m'\,S_{PD}}\,F_m = \frac{2\,C_L}{\beta_m'\,\frac{G S_m}{2}}\,F_m = \frac{C_L}{C_X} \cdot \frac{2\,C_X}{\beta_m' S_m}\,F_m \cdot \frac{2}{G} =$$

$$= \frac{C_L}{C_X} \cdot \frac{2}{G}\,\tau_{typ}$$

$$\tau_{DELAY} = \tau_{typ}\left(G + \frac{C_L}{C_X} \cdot \frac{2}{G}\right)$$

$$\frac{\partial \tau_{DELAY}}{\partial G} = \tau_{typ}\left(1 + 2\,\frac{C_L}{C_X} \cdot \left(-\frac{1}{G^2}\right)\right) =$$

$$= \tau_{typ}\left(1 - 2\,\frac{C_L}{C_X} \cdot \frac{1}{G^2}\right)$$

$$G^{*2} = 2\,\frac{C_L}{C_X} \longrightarrow G^* = \sqrt{\frac{2\,C_L}{C_X}}$$

Sia $\frac{C_L}{C_X} = 1000$ $\qquad \tau_{typ} = 15{,}747$ ps $\qquad S_m = 2 \quad S_p = 4$

$$G^* = \sqrt{2000} = 44{,}72 \simeq 45$$

$$\tau_{DELAY_{min}} \approx 15{,}747 \cdot 10^{-15}\left(44{,}72 + 1000 \cdot \frac{2}{44{,}72}\right) = 1408\ \text{ps} = 1{,}408\ \text{ns}$$

$\Delta A =$ INCREMENTO DI AREA RISPETTO ASSENZA BUFFER TRI-STATE $=$

$$= L_{min}^2 \left(G S_n + G S_n + G S_p + G S_p \right) =$$

$$= L_{min}^2 \cdot 2G \left(S_n + S_p \right) = L_{min}^2 \cdot 2 \cdot 45 \cdot (2+4) =$$

$$= 540 \, L_{min}^2$$

Se avessi usato il valore di G ottimo trovato per il buffer non tri-state. $G = \sqrt{\frac{C_L}{C_X}} \simeq 32$

$$\tau_{DELAY} = 15{,}747 \cdot 10^{-15} \left(32 + 2000 \cdot \frac{1}{32} \right) = 1488 \text{ ps} = 1{,}488 \text{ ns}$$

$$\Delta A = L_{min}^2 \, 2G \left(S_n + S_p \right) = L_{min}^2 \cdot 64 \cdot 6 = 384 \, L_{min}^2$$